PATENT SPECIFICATION

(11) 1 258 288

NO DRAWINGS

1 258 288

(21) Application No. 41714/69 (22) Filed 21 Aug. 1969
(31) Convention Application No. P 17 84 657.0 (32) Filed 2 Sept. 1968 in
(33) Germany (DT)
(45) Complete Specification published 30 Dec. 1971
(51) International Classification B 28 b 5/02 // E 04 c 2/26
(52) Index at acceptance
B5A 1R50 1R55
E1B 5A2 5C2 5CX

(54) CONTINUOUS MANUFACTURE OF SHEETS MADE OF PLASTER

(71) We, FERMA GESELLSCHAFT FUR RATIONELLE FERTIGBAUMETHODEN UND MASCHINENANLAGEN M.B.H. & Co., of 17-21 Bahnhofstrasse, 7505 Ettlingen/Baden, Germany, a Kommanditgesellschaft organised under the laws of the Federal Republic of Germany, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of continuous manufa...

mixed with the plaster in the dry state, or may be pre-dissolved in the water, or introduced into the material during the sheet-forming operation. However, up to now it has only been possible to introduce such additives into the plaster slurry to a limited extent.

There have been numerous proposals relating to particular details of the methods abovementioned. For the production of wall boards, decorative boards and acoustic boards, unwoven glass fibres ...

ERRATUM

SPECIFICATION NO 1258288

Page 2, line 71, *for* underling *read* underlying

R 12671/5

THE PATENT OFFICE
11 September 1972

... be removed. The surplus to be removed amounts to three or more times the amount required for setting the plaster.

Sheet production by the conventional methods is generally effected by charging the mixture into moulds in which it is allowed to set and from which a portion of the excess water can be removed by suction or pressure. The remainder of the water must be removed by drying out the produced sheet, and this produces a porous structure which greatly reduces the final strength and other properties of the sheet.

In order to increase the strength and elasticity of the produced sheet, it has been proposed to add additive substances to the plaster, before or during the addition of the water. These additive substances may be

... but the conditions which prevail in the case of asbestos cement are entirely different from those when using plaster, which sets in the air. In the former case, the hydraulic cement can be mixed readily with the asbestos fibres and does not separate out. Furthermore, the cement can be wetted better and sets only a long time after the wetting and shaping into sheets. In applying this dry process to the field of manufacture of plaster boards, the plaster is introduced dry into the mould, the setting water is then sprayed on, and the mass can then be subjected to a pressing process. The dry methods have the advantage that additive substances, such as wood waste (which may also contain the setting water), and fillers such as sand or slag, can easily be mixed with the dry plaster. However, only relatively thin, or laminated, sheets can be produced in this

SEE ERRATA SLIP ATTACHED

PATENT SPECIFICATION (11) 1 258 288

NO DRAWINGS

1 258 288

(21) Application No. 41714/69 (22) Filed 21 Aug. 1969
(31) Convention Application No. P 17 84 657.0 (32) Filed 2 Sept. 1968 in
(33) Germany (DT)
(45) Complete Specification published 30 Dec. 1971
(51) International Classification B 28 b 5/02 // E 04 c 2/26
(52) Index at acceptance
B5A 1R50 1R55
E1B 5A2 5C2 5CX

(54) CONTINUOUS MANUFACTURE OF SHEETS MADE OF PLASTER

(71) We, FERMA GESELLSCHAFT FUR RATIONELLE FERTIGBAUMETHODEN UND MASCHINENANLAGEN M.B.H. & Co., of 17-21 Bahnhofstrasse, 7505 Ettlingen/Baden, Germany, a Kommanditgesellschaft organised under the laws of the Federal Republic of Germany, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of continuous manufacture of sheets made of plaster (possibly with additive substances) and voluminous felting fibres.

It is known to produce sheets from plaster by forming a mixture of plaster and water which is subjected to a sheet-forming process. The amount of water added to the plaster is on the average 75% relative to the weight of the plaster. Since the plaster, however, requires only a small portion of this water for setting, the surplus water which had to be provided in order to give the mixture sufficient plasticity for sheet production must be removed. The surplus to be removed amounts to three or more times the amount required for setting the plaster.

Sheet production by the conventional methods is generally effected by charging the mixture into moulds in which it is allowed to set and from which a portion of the excess water can be removed by suction or pressure. The remainder of the water must be removed by drying out the produced sheet, and this produces a porous structure which greatly reduces the final strength and other properties of the sheet.

In order to increase the strength and elasticity of the produced sheet, it has been proposed to add additive substances to the plaster, before or during the addition of the water. These additive substances may be mixed with the plaster in the dry state, or may be pre-dissolved in the water, or introduced into the material during the sheet-forming operation. However, up to now it has only been possible to introduce such additives into the plaster slurry to a limited extent.

There have been numerous proposals relating to particular details of the methods abovementioned. For the production of wall boards, decorative boards and acoustic boards, unwoven glass fibres, textile webs or metal meshes have been incorporated in the mass to be processed in order to increase the strength of the board. These boards are expensive to produce, owing to their individual manufacture and to the use of the relatively expensive additive materials, and therefore are of only limited utility.

In order to eliminate the difficulties which result from operation with a relatively large excess of water, so-called dry processes have also been proposed. These dry processes were originally developed for the manufacture of asbestos cement sheets, but the conditions which prevail in the case of asbestos cement are entirely different from those when using plaster, which sets in the air. In the former case, the hydraulic cement can be mixed readily with the asbestos fibres and does not separate out. Furthermore, the cement can be wetted better and sets only a long time after the wetting and shaping into sheets. In applying this dry process to the field of manufacture of plaster boards, the plaster is introduced dry into the mould, the setting water is then sprayed on, and the mass can then be subjected to a pressing process. The dry methods have the advantage that additive substances, such as wood waste (which may also contain the setting water), and fillers such as sand or slag, can easily be mixed with the dry plaster. However, only relatively thin, or laminated, sheets can be produced in this

SEE ERRATA SLIP ATTACHED

way, since otherwise the setting water applied to the surface cannot penetrate sufficiently rapidly to the centre of the mass. The concept of wetting the dry gypsum as it falls into the mould during its introduction thereto fails to eliminate the difficulties and problems of continuous methods of manufacture, since separation of the plaster and additive substances is thereby facilitated and the final shaping into sheet form is made more difficult.

In order to realise a plaster board of adequate strength and capable of continuous production, the composite plaster-cardboard board was developed. This board is produced continuously by applying plaster slurry to an endless web of cardboard having its edges folded upwardly to form a mould, distributing the slurry in the cardboard mould and covering it with a second web of cardboard. The article thus obtained travels through a roller smoothing section and, after the hardening of the plaster, is cut to size and dried. The element of this composite board which determines its strength is the relatively expensive special cardboard, but this is very sensitive to moisture, which can easily warp the composite board. Also, the low strength of the plaster core makes the board difficult to lay and its edges are particularly prone to damage. In order to increase the strength of the plaster core, it has been attempted to incorporate fibrous materials, and in particular cellulose fibres, in the plaster slurry. In order to avoid excessive quantities of water which would result in a highly porous core structure, the maximum proportion of fibres in the slurry can only be 2 to 3%. Difficulties also are encountered in the utilisation of the composite board, because it has poor adhesion to finishing plaster and the cardboard facing easily loosens from the plaster core when it is wallpapered.

For continuous manufacture of plaster sheets with high percentages of reinforcing fibrous materials and as uniform as possible, the procedure eventually adopted, following the example of the paper industry, was that of forming a suspension of the fibrous materials and plaster with a large excess of water, and obtaining from the suspension by suction through a wire screen, a thin web of material consisting of plaster and fibres, winding the web on a roll and there forming it into a laminated structure of the desired thickness. While this method makes a continuous manufacture possible, it involves heavy expenditure on machinery for removal of the water, formation of the web and the winding of it, all for only a low output capacity. Furthermore the risks of producing non-homogeneous sheets and of peeling of layers in the wound sheets cannot be entirely eliminated. Differential setting in the individual webs can also lead to strong warping in the final product.

The requirements for rationalization of the building industry, in particular prefabrication and modular construction, have led to the underling aim of the present invention which is to produce plaster-board sheets, and especially large, low-cost building sheets, of good workability and improved properties by an economical continuous method which would enable voluminous felting (and thus reinforcing) fibres to be admixed in a homogeneous manner and in high proportions with the plaster (together with additive substances if desired), while at the same time working with only little more water than the plaster requires for uniform setting.

According to the present invention there is provided a method for the continuous manufacture of sheets made of plaster, with or without additive substances, and voluminous felting fibres, comprising the steps of discharging and distributing metered quantities of the dry materials comprising the plaster and the fibres from storage silos therefor onto a pre-forming endless moving band arranged ahead of a main forming endless moving band, in a manner so as to form a double-layered loose strand having the width of the sheet to be produced and consisting of a fibre layer and a plaster layer superposed one above the other, mixing said two layers of the strand together on the pre-forming band while maintaining said width of said strand, transferring the mixed strand from the preforming band to the main band, wetting the mixed strand during or after its transfer to the main band with an amount of water which is not more than 20% in excess of that necessary for setting the plaster, and compacting the wetted mixed strand on the main band by applying pressure on the strand in the direction towards the main band.

The proportion of fibres to plaster may be any desired amount by weight and may lie between about 12 to 25%, preferably, depending on the properties which the final product is to have. The particular advantage of the separate formation of the fibre bed and the plaster bed which occurs in the final strand shape on the pre-forming band resides in the fact tht it does not permit any variation in the proportions of the materials, whose bulk weights are extremely different, during the subsequent vertical mixing. The individual loose fibres are excellently surrounded and coated by plaster, do not agglomerate to form lumps in which too little binder is contained, and felt uniformly. Upon the mixing of shapeless masses it has not previously been possible sufficiently to work materials of such different bulk weights as plaster of Paris with 1000 kg/m³ and dry digested paper fibres of an average apparent

density of 20 kg/m³ to form a homogeneous mixture. These mixtures have a great tendency to separate during the further processing and not to felt together sufficiently throughout. Upon the mixing together in accordance with the invention of the fibre bed and plaster bed, introduced in strand form, the overall layer thickness is several times the thickness of the compacted sheet. In order to produce a plaster board of a thickness of 10 mm containing 20% wt. paper fibres, the strand with the layers still separated on the pre-forming band, and the mixed strand, have an overall thickness of about 100 mm. The volumentric ratio of plaster to fibres in the loose strand form is about 1:10 and in the pressed board about 1:0.25. From this it is clear that the fibres retain their felting properties until the final pressing operation.

Another particular advantage of the formation of a loose strand and the vertical mixing thereof in strand form resides in the fact that there need be introduced only a little excess water, 20% or less above the amount necessary for the uniform setting of the plaster portion itself. The amount of water, referred to the total raw material used, in the case of a pressed plaster board 10 mm thick with 20% wt. paper fibre content is only about 10 to 20% above the amount of water which the plaster requires for setting. Upon the transfer of the mixed strand onto the main forming band, the setting water may be added either under or without pressure through nozzles which are located over the entire width of the strand, and the water easily penetrates the entire loose strand as it falls freely at the place of transfer.

It is also possible to apply the setting water after the transfer of the mixed strand onto the main band and before the pressing (compacting) operation, and then incorporate it by that operation into the mixed strand, since the latter due to its loose nature favours a uniform penetration. It is furthermore possible to apply a part of the setting water to the main band and the rest to the mixed strand. In this way the introduction of the setting water during the pressing or compacting is further facilitated. The application of the setting water can, in this case, also be effected through water-containing flat structures such as felt cloths which, under the compacting pressure, give up their water to the strand of material.

Another possibility of introducing setting water which has been applied to the surface of the strand consists in removing by vacuum and prior to the compacting operation, the air contained in the loose strand, so that the applied water penetrates the strand in a positive manner and is distributed during the compacting operation.

The setting water may be introduced after the transfer of the mixed strand onto the main band, by passing the strand on the main band through a water bath and applying a pressure on the strand during passage through the water bath to effect a partial compacting or pre-compacting of the strand which controls the penetration of water into the strand from the water bath and limits the pickup of water to the desired amount. The strand may be held on the main band in the water bath by a counter-pressure band, the main band and the counter-pressure band being made as perforated bands through which a pulsating pressure is applied to the mixed strand. By the pulsation there is produced an effect similar to that produced upon the drawing off of the air by suction from the loose strand. The air enclosed in the loose strand is forced out and the setting water can penetrate thereinto.

In another modification the setting water may be supplied in the form of solid free-flowing additive substances contained in the plaster which give off the water during the compacting operation. Such additive substances can be salts or slags or other known materials. Again, the setting water may be supplied by steaming the loose mixed strand.

The setting water may contain, either dissolved or in dispersed form, additive substances which accelerate or retard the setting of the plaster, favour the penetration of the settling water, promote the adhesion of the fibres to the plaster, improve the compacting in the structure, harden the plaster, impart water-repelling properties thereto, reduce its solubility in water, increase its fire-retarding properties, impart a desired colour to the final product, or any of these. Such additive subtances can be wetting agents, synthetic resins, alum, pigments, glue, salts and the like.

Homogeneously miscible, powdered or granular additive substances, fillers or additional binders may be added. These substances may be added or admixed with the plaster either during its production or before discharge from its storage silo. They may also be applied as a separate further layer having the final strand width on the pre-forming band. The additive substances impart improved properties to the plaster with respect to the processing thereof in accordance with the method of the invention, and to the final product. As additive substances there can be employed plaster slag cement, gypsum rock, clay, sand, slag, pourable chips and the like.

Additives which promote workability of the charge material, from the stage of the mixing onwards, and which improve the properties of the final product, also may be applied during the wetting, prior to the

compacting, to the moistened or still dry strand, or after compacting and after drying as an additional after-treatment. As a result of the good compactibility of the relatively dry strand and the small porosity after drying, even small amounts of additive substances exert their full effect.

The good compactibility of the strand makes it possible to provide the pressing tools or press appendages or press supplementary equipment with surface profiling and to give the finished compacted board special architectural, optical and acoustic surface effects. The loose strand and its good compactibility thus permit a desired special formation of the board surface to be produced in an economic manner.

Surface coating of any type with liquid, paste- or powder-formed web or fleece shaped or flat materials can also be effected.

By the method of the present invention, also a laminated sheet may be produced by forming several strands of material on a corresponding number of pre-forming bands and transferring the individual strands onto a common main forming band, in a manner to form thereon a multi-layer strand of the superposed individual strands. The individual strands may be of different compositions, while nevertheless in the compacting operation a firm bond is obtained at the interfaces of the individual layers of the laminated product. In this respect, it is readily possible also to introduce flat inserts or layers into the laminated structure before compacting.

The method of the present invention will be illustrated by the following examples:

EXAMPLE 1

75 kg/min of plaster of Paris and 25 kg/min of dry digested waste paper fibres are discharged continuously from separate storage silos and separate superimposed layers of uniform thickness are formed therefrom in a strand 1 m wide on a conveyor band. The metering, discharging and strand-shaping devices are in this connection arranged one behind the other. The thickness of the plaster layer is 15 mm and that of the fibre layer 150 mm. The conveyor band (pre-forming band) travels at a speed of 5 m/min to a mixing station. Behind the mixing station the homogeneous mixed strand of material has a total layer thickness of 150 mm. Transferred onto a perforated conveyor band (main band), the mixed strand of material guided from above by another perforated conveyor band passes through a bath of water. The guide rollers of the perforated conveyor bands are made as perforated adjustable pressure rollers by which pressure is applied to the strand between the bands, to effect a partial compacting of the strand, displacing air therein and allowing the desired amount of setting water to penetrate into the strand. In the setting water there is dissolved 30 kg/m^3 of hydrated calcium chloride, which accelerates the setting of the plaster to 5 min. The main band has a speed of 10 m/min. The wetted strand leaving the water bath has a thickness of 40 mm and is further compacted to 20 mm thickness by a profiled pair of pressure rollers. A 1 mm thick layer of dry plaster, in strand form, is sprinkled uniformly over the entire width of 1 m onto the compacted profiled strand. Longitudinal and transverse cutting saws divide the strand into individual sheets or boards. After drying out the small amount of excess water, a final after-treatment is effected by the application of a bituminous coating to the non-profiled surface of the sheet or board which is not coated with plaster. The sheet or board thus obtained may be used for wall coverings as decorative and sound-insulating board. It can be arranged freely hanging or in coffers or can be cemented.

EXAMPLE 2

Similarly as in Example 1, 60 kg/min of a mixture by weight of 84% alum-treated plaster, 10% gypsum rock, 3% asbestos and 3% synthetic resin powder, and 10 kg/min of treated wood fibres are discharged and mixed in strand form on the pre-forming band. From there the loose mixed strand is transferred by free fall onto the main band, and 25% setting water, calculated on the weight of the material, is sprayed into it as it falls. On the main band the wetted strand is compacted with a compression of 20 kg/cm^2 during the setting of the plaster. By varying the speed of the main band, boards of any desired thickness, preferably from about 7 to 25 mm, can be obtained. The boards obtained have a strength of about 120 to 160 kg/cm^2, a density of about up to 1.5 kg/dm^3, high rigidity, low porosity and low solubility in water. They may be used in particular as outside and inside wall covering board.

EXAMPLE 3

A mixed strand is formed similarly as in Example 1, and transferred onto a perforated main forming band. The required amount of setting water is applied to the strand on the main band while a vacuum is produced under the band to remove air from the strand and allow the setting water to penetrate. On the main band the wetted strand is then compacted by pressure during the setting of the plaster.

EXAMPLE 4

From three pre-forming bands which are arranged above a common main band, three mixed strands of material are transferred one after another to the main band to form a three-layer strand thereon. The first and third individual strands have a weight ratio

of plaster to fibres of 9:1 and the second a ratio of 3:1. The wetting of the plaster is effected by applying part of the setting water onto the main band before it has receveid the first individual strand, and after it has received the first and second individual strands. A liquid synthetic resin solution is sprayed onto the third transferred strand. Thus wetted, the three layer strand on the main band is then compacted by passage through a continuously operating press. It is possible also to introduce a part of the setting water through the medium of a wet felt cloth which is run through the presss at the same time and surrenders its contained water under the press pressure.

In addition to the above described examples there are numerous possibilities of variation and combination. The proportion of the final product can be varied within wide limits. Modifications may be effected by widely various additives to the plaster, by pretreatment and finishing of the fibres, by additives in the setting water, by selection of the proportion of fibres and of the compacting pressure, by control of the setting process, as well as by an additional introduction or application of liquid, paste-like, powdered or flat materials during the manufacture or after drying.

Principal characteristics of the products are high strength, great rigidity, low pore volume and low solubility in water, with good working properties. Rigid boards and sheets can be sawn, drilled, milled, filed, planed, nailed, screwed, bonded, glued, painted and wallpapered. They may be made water-repellent and highly fire-resistant by means of even only small quantities of additive known for these purposes. The fields of use include interior decoration, construction of prefabricated houses, prefabrication of wall elements and the manufacture of furniture. They may be used as wall coverings and decorative, insulating and floor boards, and the like.

The method of the present invention makes possible, with relatively low outlay for equipment, a high production capacity in continuous manufacture, and all variations with respect to the metered supply of the starting materials can easily be effected. Cheap fibrous raw materials can be added in large proportions and in homogeneous and good felting manner. By the formation of the loose strand consisting of layers of material and having the width of the final board, sheets of any desired thickness can be formed. Since the process is a relatively dry one, the manufacturing equipment is kept free from soiling after the introduction of the setting water, and the costs of drying can be kept low. Another particular advantage is the control of the setting process since the strand is brought to the final sheet width even before the addition of the setting water. In this way the setting process can also be accelerated as desired, the production lines kept short or the production speed increased. The compacting of the strand can be effected at the most suitable moment during the setting of the plaster, and differences in the setting behaviour of the plaster cease to have a detrimental effect. The loose, strand having the final board width permits variation in the quantity of water for the subsequent wetting, and guarantees at all times a constant flowing and setting capacity with favourable moistening throughout. The comparatively low water factor increases the setting rate, improves the compactibility, reduces the solubility of the plaster in water and results in high mechanical properties in the final product.

WHAT WE CLAIM IS:—

1. A method for the continuous manufacture of sheets made of plaster, with or without additive substances, and voluminous felting fibres, comprising the steps of discharging and distributing metered quantities of the dry materials comprising the plaster and the fibres from storage silos therefor onto a pre-forming endless moving band arranged ahead of a main forming endless moving band, in a manner so as to form a double-layered loose strand having the width of the sheet to be produced and consisting of a fibre layer and a plaster layer superposed one above the other, mixing said two layers of the strand together on the pre-forming band while maintaining said width of said strand, transferring the mixed strand from the pre-forming band to the main band, wetting the mixed strand during or after its transfer to the main band with an amount of water which is not more than 20% in excess of that necessary for setting the plaster, and compacting the wetted mixed strand on the main band by applying pressure on the strand in the direction towards the main band.

2. A method as defined in claim 1 in which the setting water is applied to the loosely mixed strand through nozzles extending over the entire width of the strand, and while the strand falls freely in transfer from the pre-forming band onto the main band.

3. A method as defined in claim 1 in which the setting water is applied to the mixed strand and/or the main band after the transfer of the mixed strand to the main band but before the compacting operation, and the setting water is introduced into said mixed strand by the compacting operation.

4. A method as defined in claim 1 in which the setting water is applied to the mixed strand after the transfer of the mixed strand onto the main band, and the water is introduced into the mixed strand by

evacuation of air therein prior to the compacting operation.

5. A method as defined in claim 1 in which the setting water is introduced into the mixed strand by passing the strand on the main band through a water bath and applying a pressure on the strand during its passage through the water bath to effect a partial compacting of the strand which regulates the amount of water permitted to penetrate into the strand from the water bath.

6. A method as defined in claim 5 in which the mixed strand is held on the main band during passage through the water bath by a counter-pressure band, the main band and the counter-pressure band being perforated, and a pulsating pressure is applied through the perforated bands to the strand therebetween to effect the partial compacting of the strand which regulates introduction of the setting water into the strand.

7. A method for the continuous manufacture of sheets made of plaster and voluminous felting fibres, substantially as described herein.

8. A method for the continuous manufacture of sheets substantially as described in any one of Examples 1 to 4 herein.

9. A plaster-based sheet when produced by a method as defined in any one of the preceding claims.

For the Applicants.
BERNIER & BURRINGTON.
Chartered Patent Agents.
Chancery House,
53-64, Chancery Lane,
London, W.C.2.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1971. Published at the Patent Office. 25 Southampton Buildings, London WC2A 1AY from which copies may be obtained.